

We Claim:

1. A low temperature cofired ceramic-metal (LTCC-M) integrated circulator for directing radio frequency (RF) signals comprising:

5 at least one ferrite disk situated in a magnetic field caused by at least one magnet and a ferrous base plate acting as a magnetic return path;

a conductor junction having 3 ports for coupling the radio frequency signals to the circulator;

10 a plurality of LTCC-M insulating layers for positioning the at least one magnet, the at least one ferrite disk, and to support the conductor junction.

15 2. The circulator of claim 1 wherein the conductor junction forms a micro-strip transmission line for coupling the RF signals to the circulator.

3. The circulator of claim 1 wherein the conductor junction forms a stripline transmission line for coupling the RF signals to the circulator.

20 4. The circulator of claim 1 further comprising ferrite filled vias to improve the closure of the magnetic field.

5 5. The circulator of claim 1 further comprising isolated terminals on the base plate and metal vias to electrically couple the conductor junction to a printed circuit board (PCB).

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6. The circulator of claim 5 wherein the circulator is affixed to and electrically coupled to the PCB by surface mount technology (SMT).

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7. The circulator of claim 1 further comprising a resistive termination such that the composite device acts as an isolator.

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8. The circulator of claim 7 wherein the resistive termination is electrically coupled to the conductor junction by metal vias.

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9. The circulator of claim 7 wherein the resistive termination is thermally coupled to the base plate by thermal vias to remove heat dissipated by the termination.

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10. The circulator of claim 1 wherein the circulator is hermetically sealed by the LTCC-M package.

11. A method of making an LTCC-M circulator comprising the steps of:

providing one or more green sheets of insulating ceramic;

providing at least one magnet and a ferrous base plate;

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providing a contact junction;

stacking the sheets so that there is at least one insulating ceramic sheet between the magnet and the ferrite disk; and

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cofiring the stacked assembly to form an integrated LTCC-M circulator device.

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12. The method of claim 11 wherein providing one or more green sheets comprises providing green sheets comprising glass compositions and optional ceramic powders, which are mixed with organic binders and a solvent, cast and cut to form the tape, the layers having a pair of major surfaces.

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13. The method of claim 11 further comprising fabricating a conductor junction by a process selected from the group consisting of screen printing, evaporating, and sputtering.

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14. The method of claim 11 further comprising joining the layers by a method selected from the group consisting of epoxying, brazing, and soldering.

15. The method of claim 11 further comprising punching holes in the green sheets to hold electrically conductive vias for connecting the conductor junction.

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16. The method of claim 11 further comprising punching holes in the green sheets to hold thermally conductive vias for dissipating heat from the internal layers.

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17. The method of claim 11 further comprising providing a resistive termination to form an isolator.

18. The method of claim 11 further comprising providing at least one well to house the at least one magnet after cofiring.

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